A three-decade experience of radical open endvenectomy with pericardial patch graft for correction of Budd-Chiari syndrome

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Background: **We previously reported the value of our operative procedure for Budd-Chiari syndrome (BCS) that comprised reconstruction of the occluded or severely stenosed inferior vena cava (IVC) using an autologous pericardium patch and reopening as many occluded hepatic veins as possible. Here, we present the long-term durability and efficacy of the autologous pericardium patch for reconstruction of the IVC in BCS.**

Methods: **We retrospectively analyzed a series of 53 consecutive patients (mean age, 48.4 ± 12.8 years; range, 24-76 years; 34 men) who underwent surgical treatment for BCS at our institution from 1979 to 2008. Patency of the IVC and hepatic veins was examined by venography at discharge. Patients attended an outpatient clinic every 1 or 2 months for follow-up. The reconstructed IVC was evaluated by enhanced computed tomography every 1 or 2 years.**

Results: **Two in-hospital (operative mortality, 3.7%) and 15 late deaths occurred. During a mean follow-up of 7.6 ± 6.5 years (range, 0.08-24.1 years), the reconstructed IVC became totally obstructed in three patients, of whom two underwent reoperation, and severely stenosed in two patients, who required percutaneous transvenous balloon venoplasty (PTV). The 5- and 10-year patency rates without reoperation or PTV for the reconstructed IVC were 90.5% and 84.3%, respectively. The cumulative 5- and 10-year survival rates were 89.8% and 70.7%, respectively.**

Conclusion: **The autologous pericardium patch is effective and durable for reconstructing a diseased IVC in BCS. (J Vasc Surg 2009;50:590-3.)**

Budd-Chiari syndrome (BCS) is defined as chronic, progressive, and congestive liver dysfunction resulting in liver cirrhosis and hepatic failure due to hepatic inferior vena cava (IVC) obstruction concomitant with ostial obstruction of the hepatic vein. We previously described our corrective procedure for BCS that consists of reconstruction of the occluded IVC using autologous pericardium patch and reopening as many occluded hepatic veins as possible.[1-3]

Malignant involvement of the IVC or superior vena cava (SVC) is sometimes surgically treated using autologous pericardium, which is considered good material for patch reconstruction after partial resection of the IVC or SVC.[4-7] We previously demonstrated that autologous pericardium is more effective than bovine or horse pericardium and expanded polytetrafluoroethylene (ePTFE) for reconstruction of the IVC in dogs.[8] However, the long-term durability and efficacy of this autologous pericardium after patch reconstruction of the IVC in patients with BCS is unclear. To clarify the effectiveness and long-term durability of the autologous pericardium for patch reconstruction of the IVC, we retrospectively reviewed patients with BCS who had undergone our surgical corrective procedure.

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PATIENTS AND METHODS

We enrolled 53 consecutive patients (34 men) who had undergone this corrective procedure for BCS at Ryukyu University Hospital between December 1979 and January 2008. The patients were a mean age of 48.4 ± 12.8 years (range, 24-76 years). Major symptoms or signs were lower extremity edema in 11, abdominal distension in 10, hepatic encephalopathy in 6, hepatomegaly in 5, superficial collateral veins on the abdomen in 5, varicose vein or pigmentation of the leg in 5, gastrointestinal bleeding in 4, and abdominal pain in 2. All patients had ascites at the operation. Three patients had associated Behçet's disease, 6 had a protein C deficiency, 5 had protein S deficiency, and 1 had antiphospholipid antibody syndrome. Esophageal varices were confirmed in 46 patients (87%), of which six (11.3%) had a history of hepatic encephalopathy.

The mean pressure gradient between the right atrium (RA) and IVC was 12.0 ± 3.4 mm Hg (range, 8-21 mm Hg). The 15-minute indocyanine green clearance test (ICG 15') was 30.4% ± 16.4% (range, 5.3%-68%). Preoperative venography showed that the obstructed or stenosed lesion of the IVC was 3.0 ± 2.6 cm (range, 0-12 cm) in length. Three patients had undergone previous catheter intervention to the IVC stenosis. Our surgical indication for BCS is an IVC obstruction or severe stenosis resulting in elevation of the pressure gradient between RA and IVC, with or without a hepatic vein with ostial obstruction, which is thought to be able to be reopened by our procedure, simultaneously.

The patients were placed in the left lateral position under unilateral ventilation, and the lateral site of the

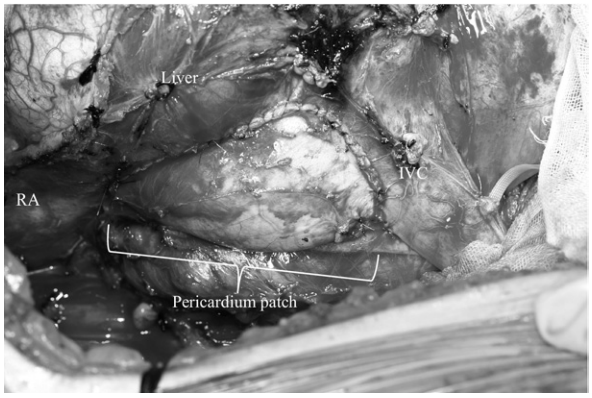

Fig 1. Reconstructed retrohepatic inferior vena cava *(IVC)* with fresh autologous pericardium patch. *RA,* right atrium.

hepatic IVC and the right atrium were exposed by dividing the diaphragm and right sixth intercostals by a thoracotomy. Harvested fresh autologous pericardium was immersed in saline and used to reconstruct the occluded or severely stenosed IVC (Fig 1). We concomitantly reopened as many occluded hepatic veins as possible under a partial cardiopulmonary bypass (CPB) through the right femoral artery and vein cannulation. A thickened caval wall that occluded the ostia of the hepatic veins was partially resected with some liver parenchyma to reopen and dilate the hepatic venous outflow. The concept of lateral patch augmentation and resection of liver parenchyma is to widen and deepen the occluded or severely stenosed hepatic IVC and normalize hepatic circulation from the portal vein to the RA through the hepatic veins.

All patients received continuous intravenous heparin sulfate at a dose of 100 U/kg/day within 24 to 48 hours postoperatively, followed by lifelong warfarin therapy at doses required to maintain the international normalized ratio between 1.5 and 2.5.

All surviving patients underwent venography and the ICG 15' test at discharge and were followed up every 1 or 2 months as outpatients. The reconstructed IVC was evaluated by enhanced computed tomography (CT) scanning every 1 or 2 years. During the follow-up period, 129 CT images of the surviving patients, with an average of 4.3 images per patient (range, 1-14 images) were reviewed. When restenosis or occlusion of the hepatic IVC was indicated on scans, the patients underwent venography. The last imaging study that confirmed graft patency served as the end point for graft patency calculations.

Statistical analysis was performed with Statview 5.0 software (SAS Institute, Cary, NC). All data were expressed as mean ± SD. The survival rate and the patency rate without reoperation and transvenous balloon venoplasty (PTV) for the reconstructed IVC were estimated using the Kaplan-Meier product limit method. For comparison between two groups, significance was determined by the *t* test. A value of $P < .01$ was considered significant.

RESULTS

The duration was 298.5 ± 83.4 minutes (range, 180-567 minutes) for the procedure and 30.5 ± 15.5 minutes (range, 13-71 minutes) for CPB. The harvested pericardium was 72 (range, 40-120) × 34 (range, 24-86) mm. Two patients died in the hospital at postoperative day 15 for an operative mortality of 3.7%. One patient died of severe liver failure and the other died of ventricular fibrillation from cardiac amyloidosis. The postoperative hospital length of stay was 49 ± 22 days (range, 15-124 days). Complications developed in 11 patients, consisting of pleural effusion in 5, postoperative bleeding in 2, wound infection in 2, renal dysfunction in 1, and acute hepatitis in 1. Symptoms were acceptably reduced in all survivors, with no evidence of hepatic failure.

All survivors underwent venography at discharge, which revealed the absence of occlusion and severe stenosis in the reconstructed IVC. The mean pressure gradient between the RA and IVC was significantly decreased from 12.0 ± 3.4 (range, 8-21) to 4.0 ± 3.0 (range, 0.0-12.0) mm Hg ($P < .001$). The ICG 15' was also significantly decreased from 30.4% ± 16.4% (range, 5.3%-68%) to 19.7% ± 14.6% (range, 5.5%-56.6%; $P < .001$). The serum bilirubin and platelet count were significantly recovered from 1.62 ± 0.7 (range 0.6-3.4) to 1.19 ± 0.67 (range, 0.3-4.0) mg/dL ($P < .001$) and from 11.5 ± 7.5 (range, 2.0-48.4) × $10^4/mm^3$ to 16.3 ± 7.8 (range, 3.6-35.0) × $10^4/mm^3$ ($P < .001$). The esophageal varices disappeared in 11 of 46 patients (23.9%).

No graft infections developed during the mean follow-up period of 7.6 ± 6.5 years (range, 0.08-24.1 years). Total obstruction of the reconstructed IVC occurred in three patients at 5, 6, and 7 years, respectively, after the initial surgery. Two of three patients with total obstruction, whose symptoms of lower extremity edema and esophageal varices deteriorated despite medical treatment, underwent a repeat procedure. One patient underwent repeated IVC reconstruction using a ring-reinforced ePTFE graft, and another underwent a Senning-type RA-liver anastomosis. Four presented with severe stenosis of the reconstructed IVC that was treated using PTV. The 5- and 10-year patency rates without reoperation or PTV for the reconstructed IVC were 90.5% and 84.3%, respectively (Fig 2). The remaining patients did well with considerable improvement of symptoms that were documented before surgery and no progression of the liver dysfunction during the follow-up period. Hepatocellular carcinoma developed in 13 patients (24.5%), and they underwent partial hepatic resection 5.3 ± 5.4 years (range, 0-17.6 years) after the BCS surgery, including a one-stage operation in three patients.

There were 15 late deaths caused by hepatocellular carcinoma in 2 patients, pneumonia in 2, respiratory failure in 1, arrhythmia in 1, suicide in 1, liver failure in 1, and an unknown cause in 7. The cumulative 5- and 10- year survival rates were 89.8% and 70.7%, respectively (Fig 3).

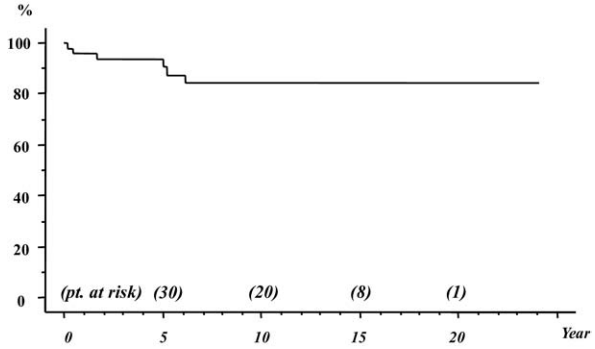

Fig 2. Cumulative patency rates without reoperation or percutaneous transvenous balloon venoplasty. Patency rates are 90.5% at 5 years and 84.3% at 10 years.

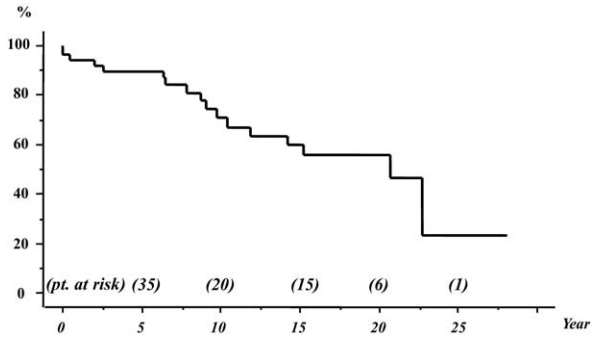

Fig 3. Cumulative survival rates were 89.8% at 5 years and 70.7% at 10 years.

DISCUSSION

These results suggest that autologous pericardium can serve as an effective and durable patch for IVC reconstruction in BCS. Because of its geometric and functional advantages, antibacterial and anticoagulant potential, long-term durability without calcification, and its cost, the autologous pericardium is considered an excellent material for reconstructive heart surgery[9-15] and for treating tumors with vascular involvement and thrombosis.[4-7] It has been applied in many reconstructive procedures such as right ventricular outflow tract repair of tetralogy of Fallot, aortic arch reconstruction in hypoplastic left heart syndrome, heart valve repair, and aortic root repair in aortic valve endocarditis.[9-15]

Our previous immunohistologic findings[8] also support the use of autologous pericardium for IVC reconstruction in terms of the quality of the neointima of grafts after patch reconstruction of the IVC in dogs. Moreover, the pericardium can be easily harvested through a thoracoabdominal incision approached through the retrohepatic IVC and RA in patients with BCS.

The autologous pericardium has some limitations, however. The size of the pericardium available for harvest using our approach might be insufficient for IVC repair in patients who have already undergone cardiac surgery or our procedure for BCS, so an alternative material is required for such patients. The ePTFE graft that has mostly been used for IVC replacement or patch reconstruction in patients with tumors or thrombus involving the IVC is considered a good material for treating patients with BCS from the viewpoints of size-matched IVC, resistance to compression, and high patency rates, regardless of anticoagulant therapy.[16-19]

One of two patients with an obstructed IVC required repeated patch augmentation with an external supported ePTFE graft 6 years after the first operation; however, severe edema of both feet developed 16 years after the repeat operation. Venography revealed severe stenosis of the proximal site of the graft, and the pressure gradient across this stenosis site had increased from 0 (at the first operation) to 8 mm Hg. PTV did not resolve his symptoms or reduce the pressure gradient due to sclerotic change at the stenosis site of previous ePTFE graft. Three other patients with severe stenosis of the autologous pericardium underwent successful PTV. These findings suggested that the anastomotic site of the ePTFE graft might undergo long-term sclerotic changes.

In the setting of anticoagulation therapy, inherited and acquired hypercoagulable states along with a variety of other causes can be identified in about 75% of patients with BCS, indicating that several etiologic factors are involved in 25% of these patients.[20] Therefore, our patients were administered indefinite postoperative warfarin therapy. In fact, six (11%) of our patients with BCS had inherited and acquired hypercoagulable states. Moreover, the two in-hospital deaths occurred in patients who had hypercoagulable states and presented fulminant liver failure before surgery.

Transjugular intrahepatic portosystemic shunt (TIPS) is thought to be feasible and effective in patients with fulminant or acute BCS, and is also useful as a bridge to liver transplantation. The long-term success of the TIPS is limited, however, particularly in patients with liver cirrhosis.[21,22] In our series, 32 patients (60.3%) had histologic liver cirrhosis, and their cumulative survival rates were 93.3% at 5 years and 78.2 % at 10 years. So, TIPS should be considered as a bridge to definitive surgery in case of fulminant or acute liver failure of BCS with liver cirrhosis.

CONCLUSIONS

Fresh autologous pericardium is an effective and durable patch for reconstruction of the IVC in BCS. This technique has a good long-term outcome. We consider that long-term anticoagulant therapy with warfarin is necessary for such hypercoagulable states.

AUTHOR CONTRIBUTIONS

Conception and design: HI, YM, TN, KA, SY, YK
Analysis and interpretation: YM, TN, KA, SY, YK
Data collection: HI, YM, TN, KA, SY, YK, KK
Writing the article: HI
Critical revision of the article: SY, YK, KK

Final approval of the article: HI, YM, TN, KA, SY, YK, KK
Statistical analysis: HI
Obtained funding: YK
Overall responsibility: HI

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